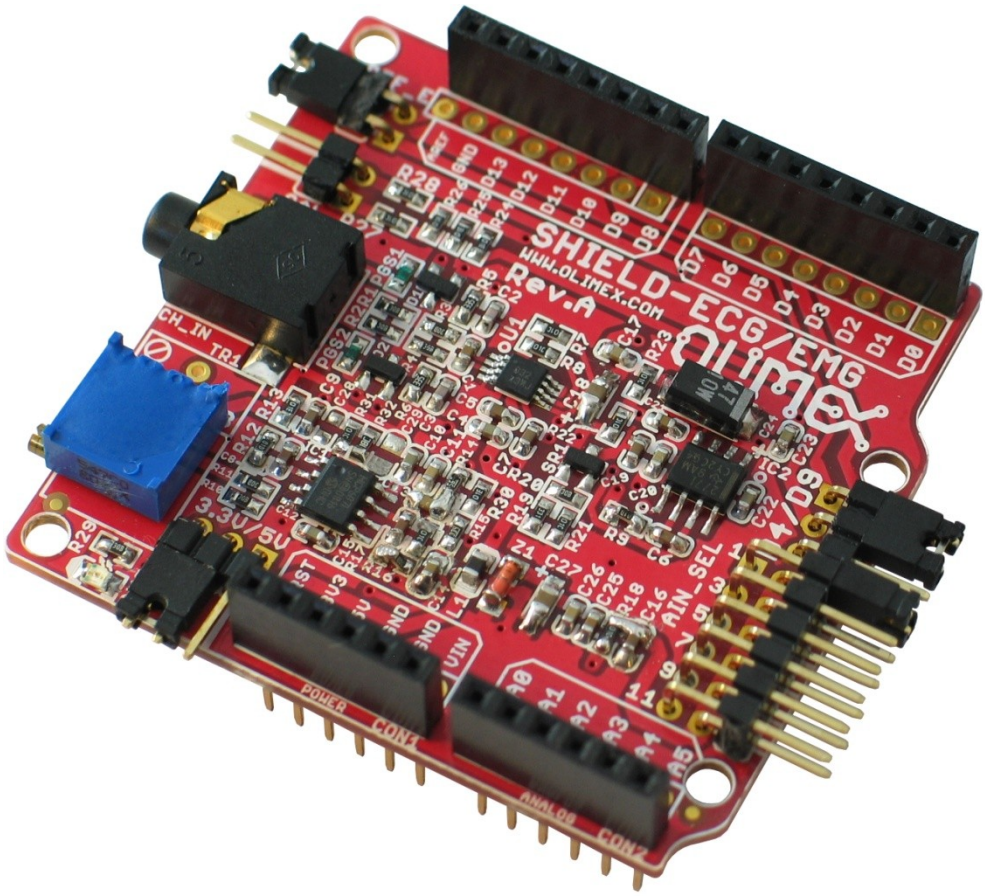

SHIELD-EKG-EMG bio-feedback shied
USER'S MANUAL

All boards produced by Olimex LTD are ROHS compliant

lead-free

Initial release, Januray 2012

Designed by OLIMEX Ltd, 2011

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Thank you for purchasing the SHIELD-EKG-EMG - engineered and assembled by Olimex LTD!

WARNING:

EKG DEVICE DISCLAIMER

IEC601 is a standard that specifies tests and requirements that medical devices must pass before they can be used on humans. However, none of the devices built from these designs have been tested according to these guidelines because of the costs involved. Therefore, a device based on any of these designs may not be used for medical purposes as no medical claims are made.

Note that CONNECTING A DEVICE VIA ELECTRODES TO HUMANS OR ANIMALS IS POTENTIALLY HAZARDOUS AND MAY RESULT IN ELECTRIC SHOCK AND/OR SEIZURE.

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SECTION 1
OVERVIEW

Thank you for choosing the SHIELD-EKG-EMG prototype board from Olimex! This document provides a User's Guide for the Olimex SHIELD-EKG-EMG. As an overview, this chapter gives the scope of this document and lists the board's features. The document's organization is then detailed.

1.1 Scope

The SHIELD-EKG-EMG is an extension module for Olimex's ARDUINO compatible boards – like OLIMEXINO-328, OLIMEXINO-STM32 and PIC32-PINGUINO, among others. The shield is also compatible with ARDUINO boards including ARDUINO UNO. The board comes with mounted connectors on it.

1.2 Features

- Stackable shield (pass-through headers) - up to 6 shields forming 6 channels; mounted on top of each other and wired to A0-A6 analogue inputs
- Calibration signal generation by D4/D9 digital output
- Preciese Trimmer potentiometer for calibration (all boards are shipped completely assembled, tested and calibrated so you should not do this unless you wat to see how things work)
- Input connector for passive or active electrodes
- Works with both 3.3V and 5V Arduino boards

1.3 Similar boards

MOD-EEG-SMT - an inexpensive unit for electroencephalography (EEG) - recording of electrical activity along the scalp: http://www.olimex.com/gadgets/eeg-smt.html

PROTO-SHIELD - If you seek a board which follows the DUINO shield dimensions specification and offers prototype area and 2 buttons with filter capacitors and 2 LEDs. Web page of the product: http://olimex.com/dev/proto-shield.html

SHIELD-LOL – If you are searching for a shield with 126 LED matrix (14x9) available in 4 colors and 4 different sizes of the LEDs. Web page: http://olimex.com/dev/shield-lol.html

1.4 Organization

Each section in this document covers a separate topic, organized as follow:

- Section 1 is an overview of the board usage and features
- Section 2 provides a guide for quickly setting up the board and introduces the user to Arduino/Maple/Pinguino
- Section 3 contains the general board diagram and layout
- Section 4 show and example of setting up SHIELD-EKG-EMG with OLIMEXINO-328
- Section 5 covers the connector pinout, peripherals and jumper description
- Section 6 provides the schematics
- Section 7 contains the revision history

SECTION 2
SETTING UP THE SHIELD-EKG-EMG PROTOTYPE BOARD

This section helps you set up the SHIELD-EKG-EMG development board for the first time.

Please consider first the electrostatic warning to avoid damaging the board, then discover the hardware and software required to operate the board.

The procedure to power up the board is given, and a description of the default board behavior is detailed.

2.1 Electrostatic Warning

The SHIELD-EKG-EMG development board is shipped in a protective anti-static package. The board must not be exposed to high electrostatic potentials. A grounding strap or similar protective device should be worn when handling the board. Avoid touching the component pins or any other metallic element.

2.2 Requirements

In order to set up the SHIELD-EKG-EMG prototype board, the following items are required:

- SHIELD-EKG-EMG itself
- ARDUINO compatible board* (e.g. OLIMEXINO-328, OLIMEXINO-STM32, PIC32-PINGUINO)
- Electrode cable**

*The pinout for the board strictly follows the DUINO extension specification. Best choice for a board would be OLIMEXINO-328 or any DUINO board which utilizes the ATmega328 since we have working and tested examples for those MCUs, configuring them for ATmega128 would require tweaking of the code.

**The cable features three electrodes – two data electrodes (1 channel) and DLR electrode (feedback). If you use more than one SHIELD-EKG-EMG you can use cables without DLR for every shield after the first.

IMPORTANT NOTE: The electrode cables for SHIELD-EKG-EMG and MOD-EEG-SMT differ from each other.

In case you want to build a working SHIELD-EKG-EMG system without owning a DUNIO board the best choice would be our board OLIMEXINO-328. This is the web page for the board: http://www.olimex.com/dev/olimexino-328.html.

2.3 Powering up the board

The SHIELD-EKG-EMG board is powered by the host board it is mounted on. There is the option to be powered either by 3.3V or 5.0V host board (configured easily by a jumper).

On powering the board PWR LED must become GREEN.

2.4 Arduino/Maple/Pinguino note

What is Arduino?

Arduino is an open-source electronics prototyping platform, designed to make the process of using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open hardware design for the Arduino board with an Atmel AVR processor and on-board I/O support. The software consists of a standard programming language and the boot loader that runs on the board.

Arduino hardware is programmed using a Wiring-based language (syntax + libraries), similar to C++ with some simplifications and modifications, and a Processing-based Integrated Development Environment (IDE).

The project began in Ivrea, Italy in 2005 aiming to make a device for controlling student-built interaction design projects less expensively than other prototyping systems available at the time. As of February 2010 more than 120,000 Arduino boards had been shipped. Founders Massimo Banzi and David Cuartielles named the project after a local bar named Arduino. The name is an Italian masculine first name, meaning "strong friend". The English pronunciation is "Hardwin", a namesake of Arduino of Ivrea.

More information could be found at the creators web page http://arduino.cc/ and in the Arduino Wiki http://en.wikipedia.org/wiki/Arduino

To make the story short - Arduino is easy for beginners who lack Electronics knowledge, but also does not restrict professionals as they can program it in C++ or mix of Arduino/C++ language.
There are thousands of projects which makes it easy to startup as there is barely no field where Arduino enthusiasts to have not been already.

Arduino has inspired two other major derivates - MAPLE and PINGUINO. Based on 8-bit AVR technology the computational power of Arduino boards is modest, this is why a team from MIT developed the MAPLE project which is based on ARM7 STM32F103RBT6 microcontroller. The board have same friendly IDE as Arduino and offers the same capabilities as hardware and software but runs the Arduino code much faster. The Maple project can be found at http://leaflabs.com

In parallel with Arduino another project was started called PINGUINO. This project chose its first implementation to be with PIC microcontrollers, as AVRs were hard to find in some parts of the world like South America so it is likely to see lot of PINGUINO developers are from that part of the world. PINGUINO project founders decided to go with Python instead Java for processing language. For the moment PINGUINO is much more flexible than Arduino as it is not limited to 8bit microcontrollers. Currently the IDE, which has GCC in

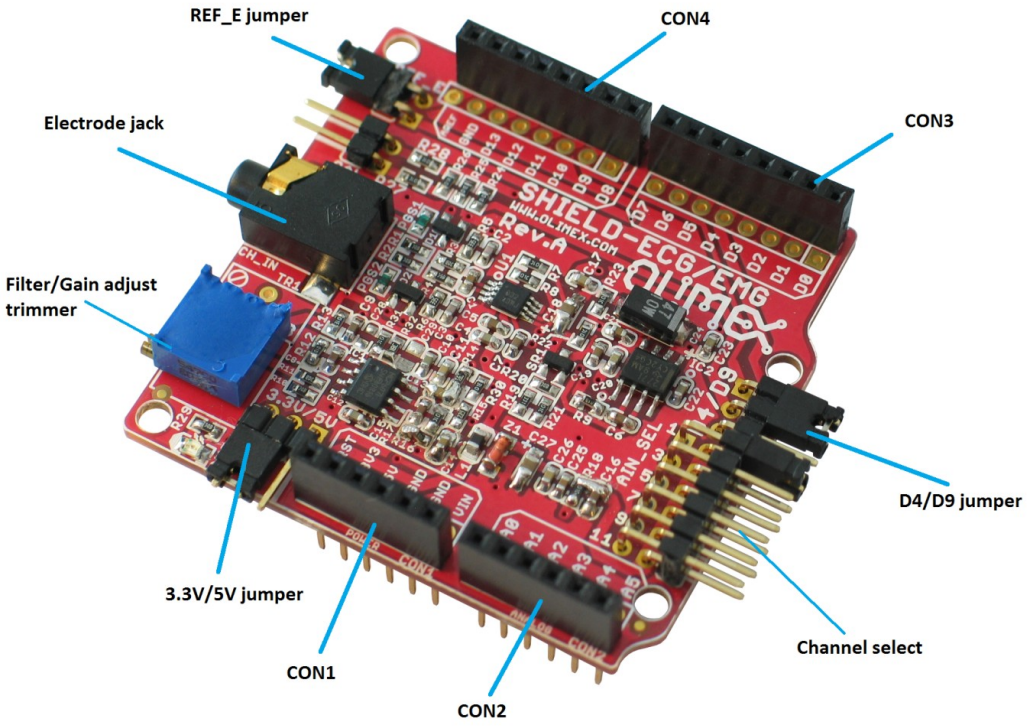
background, can support 8-bit PIC microcontrollers, 32bit PIC32 (MIPS) microcontrollers and ARM7/CORTEXM3 microcontrollers which makes PINGUINO very flexible because once you make your project you can migrate easily through different hardware platforms and not being bound to a single microcontroller manufacturer. The PINGUINO project can be found at: http://www.pinguino.cc.

SECTION 3
SHIELD-EKG-EMG BOARD DESCRIPTION

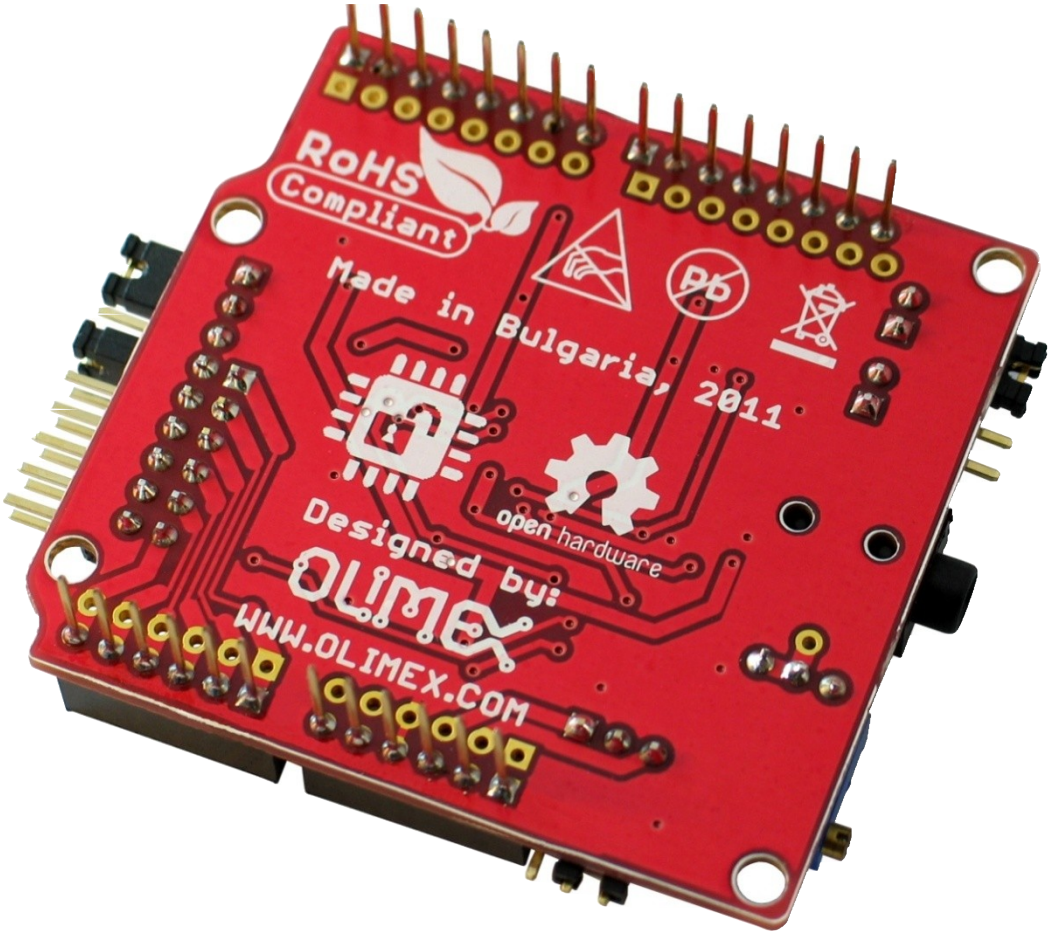
Here you get acquainted with the main parts of the board. Note the names used on the board differ from the names used to describe them. For the actual names check the SHIELD-EKG-EMG board itself.

For example: BUTTON (seen on the op view below) is named BUT; RESET is named RST; etc

3.1 Layout (Top view):



3.2 Layout (Bottom view):



SECTION 4
INSTALLATION EXAMPLE

This is a step by step example of installing SHIELD-EKG-EMG on OLIMEXINO-328 using Windows. You can refer to the tips keeping in mind that the example utilizes a board with ATmega328 MCU.

4.1 SHIELD-EKG-EMG and OLIMEXINO-328

In this example we use OLIMEXINO-328; SHIELD-EKG-EMG; USB - USBmini cable; Arduino 1.0 IDE; two external libraries for the IDE (the latest versions of TimerOnev9 and FlexiTimer2); the latest FTDI VCP drivers (2.08.14), demo code provided by us that can be downloaded from the web site and free monitoring software Electric Guru.

1. Download and extract the Arduino 1.0 IDE package from the Arduino web site: http://www.arduino.cc/

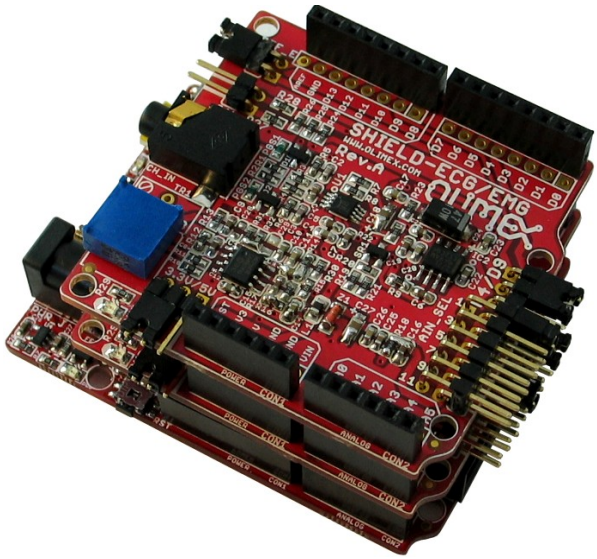
2. Download and place the two timer libraries required(TimerOne, FlexiTimer2) in \arduino-1.0\libraries by placing each of them in properly named folder (check the other libraries for reference)
http://arduino.cc/playground/Code/Timer1
http://www.pjrc.com/teensy/td_libs_MsTimer2.html

3. Download the demo project from product's web page:
http://www.olimex.com/dev/shield-ekg-emg.html

4. Download the FTDI VCP drivers: http://www.ftdichip.com/Drivers/VCP.htm

5. Set the jumpers of SHIELD-EKG-EMG in the following way:

REF_E – closed
3.3V/5V – 5V position
D4/D9 – D9 position
ANI_SEL – 1 position (channel)



6. Connect the shield to the board

7.Connect OLIMEXINO-328 to the USB

8. Install the VCP FTDI drivers by going in *Device Manager*; right-clicking over the unrecognized device and choosing *Update Driver* and then pointing to the folder where you downloaded and extracted the FTDI VCP driver.

Here it is advisable to go to *Device Manager* and from advanced settings of our recognized USB Serial Port (COMx) device to set x to a free port between 1 and 4 (because the monitoring software in this example can read only from COM ports 1 to 4).

9. Start Arduino IDE 1.0 and open the provided by Olimex project ShieldEkgEmgDemo.pde

10. Set Tools -> Board -> Arduino Duemilanove w/ ATmega328

Set Tools -> Serial port -> the COM we configured our board at

11. Click Upload (->)

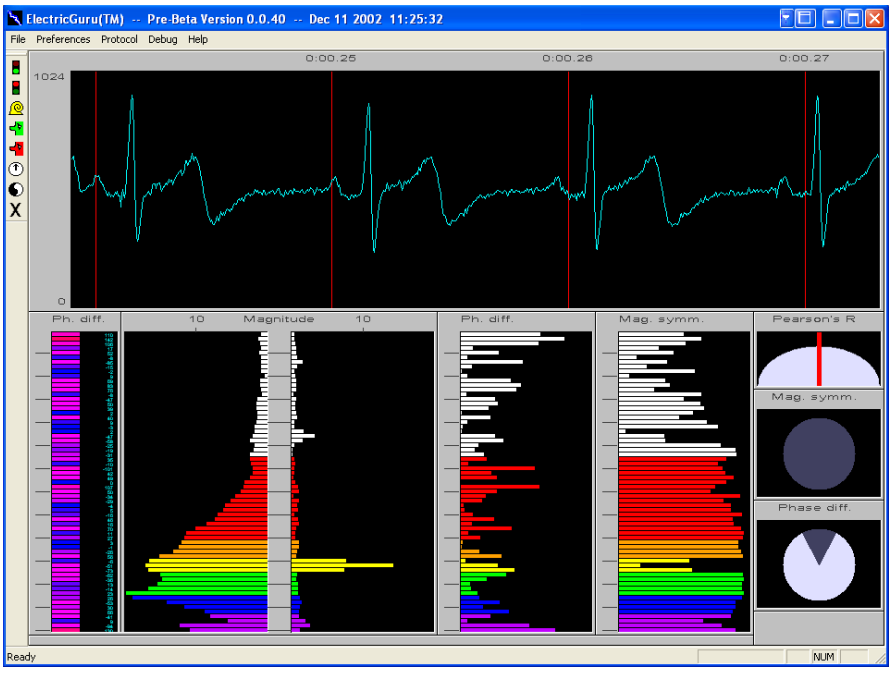
12. Download, install and start the software from this page: http://www.realization.org/page/topics/electric_guru.htm

13. It is advisable to adjust the settings in your ElecGuru program in Preferences-> Trace (waveform)… (depending how many channels/shields you use)

14. Choose the COM port your OLIMEXINO is connected to from Preferences -> Serial port… (Remember you have to set it to COM 1 to 4)

15. You connect the electrodes to your right arm, left arm and the DLR to your right leg

16. Start monitoring, adjust the settings until you receive an image like the one shown on the picture



SECTION 5
HARDWARE

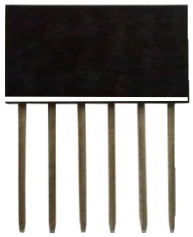
You can get a good view of the hardware observing the board. All pins, connectors and jumpers are named individually.

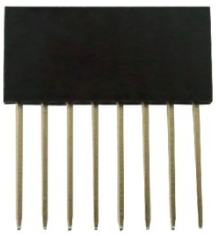
5.1 Arduino shield connector

These connectors follow the ARDUINO specification for shield connection. The shield comes with soldered connectors making it ready for mounting on compatible board with the possibility to have another shield mounted on it.

Pin #	POWER CON1	ANALOG CON2	DIGITAL CON3	DIGITAL CON4
1	RST	A0	D0	D8
2	3.3V	A1	D1	D9
3	5V	A2	D2	D10
4	GND	A3	D3	D11
5	GND	A4	D4	D12
6	Vin	A5	D5	D13
7	-	-	D6	GND
8	-	-	D7	AREF

6-pin and 8-pin connectors mounted (CON1, CON2 and CON3, CON4):





5.2 Trimmer TR1

Trimmer TR1 is calibrated during the factory testing. However it may be adjusted for the gain. Use at own risk.

5.3 Jumper description

The names of the jumpers on the board correspond to the bold names used below:

3.3V/5V

This jumper controls the power circuit. Whether powered by 3.3V or 5V board.

Default state is 3.3V.

REF_E

If you use only one shield this jumper has to be closed.
If you have multiple shields the first one should be closed; the respective REF_E jumpers on every other shield above it should be open.

Default state is closed.

AIN_SEL

This jumper is responsible for which channel the current SHIELD-EKG-EMG would utilize. If you have more than one shield one of them should have AIN_SEL in position 1, the second in position 3, etc.

Default state is in position 1.

D4/D9

Controls pin D4/D9. Some processors utilize the default D9 pin so you have to switch to D4. This jumper provides easy option to do so.

Default state is D9.

CAL

CAL jumper is used for feedback of the calibration and requires additional cable.

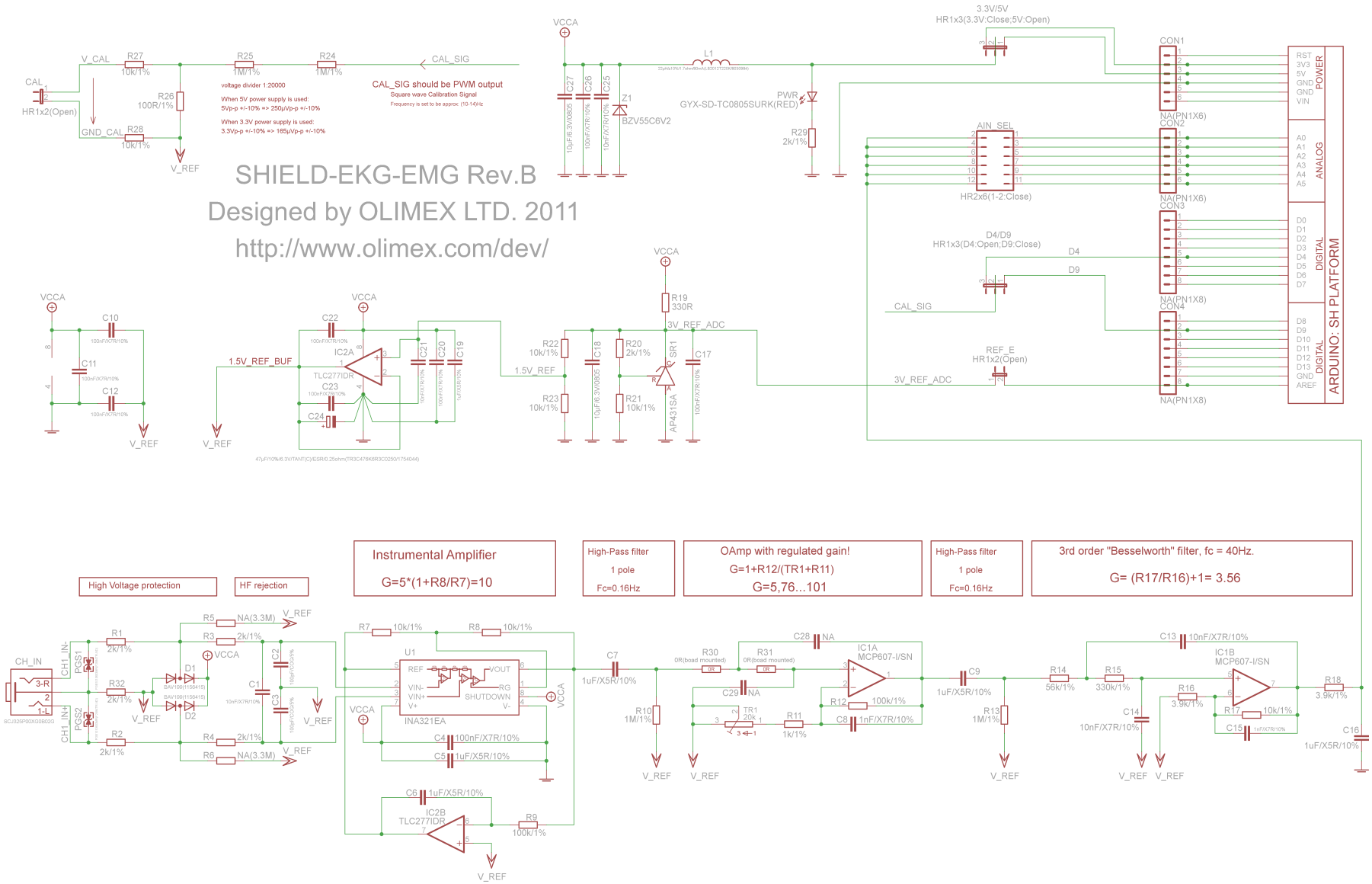
Default state is open.

SECTION 6
SCHEMATICS

6.1 Eagle schematics

SHIELD-EKG-EMG schematic is visible for reference here. But you can find it with better resolution and stand-alone on the product's web page: http://olimex.com/dev/shield-ekg-emg.html. They are located in HARDWARE section.

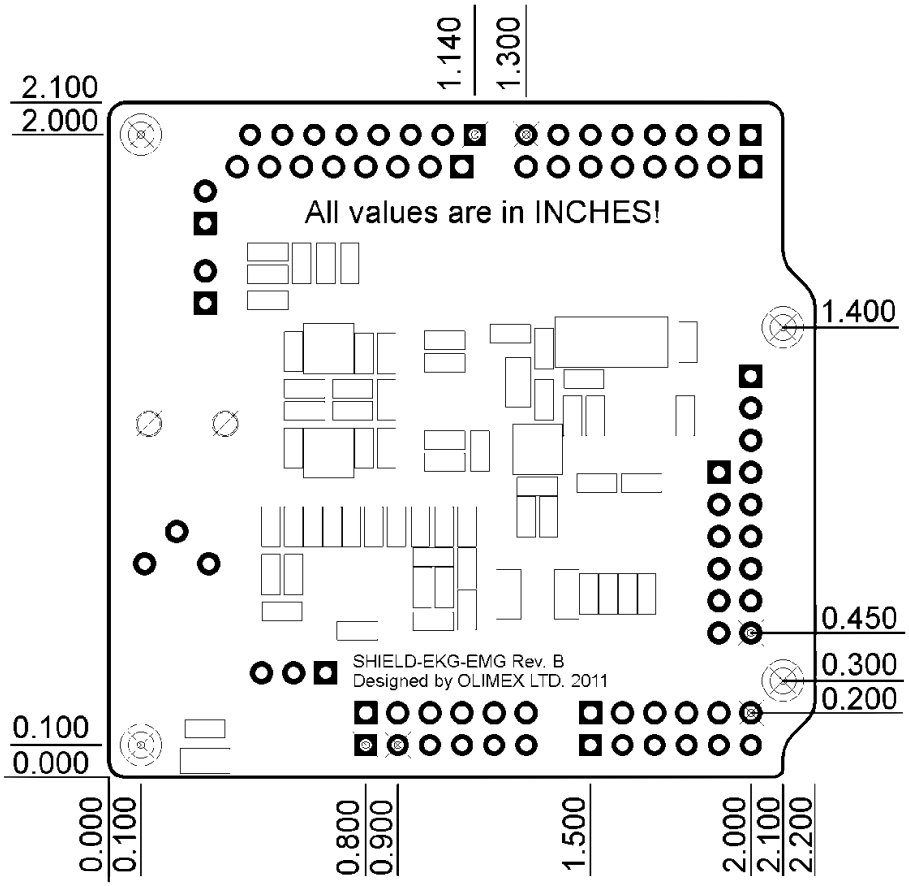
The EAGLE schematic is situated on the next page for quicker reference.


SHIELD-EKG-EMG Rev.B
Designed by OLIMEX LTD. 2011
http://www.olimex.com/dev/
CAL_SIG should be PWM output
Square wave Calibration Signal
voltage divider 1:20000
When 5V power supply is used:
5Vp-p +/-10% => 250µVp-p +/-10%
When 3.3V power supply is used:
3.3Vp-p +/-10% => 165µVp-p +/-10%
3.3V/5V
HR1x3(3.3V:Close;5V:Open)
D4/D9
HR1x3(D4:Open;D9:Close)
REF_E
HR1x2(Open)
AIN_SEL
HR2x6(1-2:Close)
ARDUINO: SH PLATFORM
POWER
ANALOG
DIGITAL
Instrumental Amplifier
G=5*(1+R8/R7)=10
High-Pass filter
1 pole
Fc=0.16Hz
OAmp with regulated gain!
G=1+R12/(TR1+R11)
G=5,76...101
High-Pass filter
1 pole
Fc=0.16Hz
3rd order "Besselworth" filter, fc = 40Hz.
G= (R17/R16)+1= 3.56
High Voltage protection
HF rejection
INA321EA
TLC277IDR
MCP607-I/SN
AP431SA
BZV55C6V2
GYX-SD-TC0805SURK(RED)

6.2 Physical dimensions

As you can see below the dimensions follow the classic Arduino shield pin specification making it compatible with all Olimex Duino boards.

Note: All dimensions are in inches!



SECTION 7
REVISION HISTORY

7.1 Document revision

Revision	Changes	Modified Pages
A	Initial Creation	All

7.2 Web page of your device

The web page you can visit for more info on your device is http://www.olimex.com/dev/shield-ekg-emg.html. There you can find more info and some examples.

7.3 Ordering info

ORDER CODES:

SHIELD-EKG-EMG - completely assembled and tested

OLIMEXINO-328 – Arduino based board with ATmega328, fully compatible with SHIELD-EKG-EMG

How to order?

You can order to us directly or to any of our distributors.
Check our webpage http://www.olimex.com/ for more info.